COMPARISON STUDY OF USING DIFFERENT CURING CONDITION OF TIRE POWDER RUBBER IN CONCRETE

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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Thesis submitted in fulfillment of the requirements
for the award of the degree of
Bachelor Degree in Civil Engineering

Faculty of Civil Engineering and Earth Resources

UNIVERSITI MALAYSIA PAHANG

MAY 2019

ACKNOWLEDGEMENTS

First and foremost, all the praise and thanks are to the Almighty Allah, for giving me the strength to complete this final year project as a requirement for graduation of the bachelor's degree Eng. (Hons.) Civil Engineering from University Malaysia Pahang (UMP).

Secondly, I would like to thank a number of people, to whom I am greatly indebted. Without them, this research might not have been successfully accomplished. I wish to express my gratitude to my supervisor, Dr. Doh Shu Ing for his patience and guidance throughout this study. Thank you for believing in my abilities and for giving me the foundation to explore further in this area. I would like also to thank the technical staffs of Civil Engineering Concrete Laboratory UMP for helping and guiding me during conducting the lab tests. Moreover, my thanks to all my friends who helped, supported and motivated in my study and in my personal life which their encouragement and motivation are highly appreciated.

Not to be forgotten, my parents who have always support me through my overseas journey and made every opportunity available to me throughout my life. Even thought, they are far away, their prayers and blessings are immensely appreciated which I may not be able to repay. I would like also to thank my family's members specially my brother Ahmed for his continuous support.

ABSTRACT

Motorcar waste tyre has a steady increase in its generation annually in Malaysia. The number of motorcar waste tyres generated annually in the country was estimated to be 8.2 million or approximately 57,391 tons in the year 2006. In addition to this, 60% of the waste tyres are disposed via unknown routes. Waste tyres in Malaysia are neither categorized as solid waste or hazardous waste. Currently it is just generalized as trade waste. Since there isn't any law or regulation which governs waste tyre management, we have decided to use this material. From the previvors studied it shows that Tire waste is non-environmentally friendly which consist of a complex structure. A structure that is unbreakable by nature normal reaction and unable to be recycled. This work determines the mechanical properties of concrete after partial sand replacement and compare the effect of using two types of concrete curing which are water curing and salt curing in compressive strength and flexural strength. The tyre waste used in this research is grinded into powder form and then used partially to replace sand in a concrete mix design to find its suitable percentage to be used to gain the optimum strength. The concrete cubes tested in this research are sized at (150mm x 150mm x 150mm) each and tested at different percentage of sand replacement. The cubes are casted at a 0% (controlled cube), 5% and 10%. Each percentage had 9 identical cubes casted to get an average data that was tested on the 7th and 28th day since it was casted. Moreover, for flexural test, 18 beams size 500mm x 100mm x 100mm Flexural strength decreased with increasing tyre rubber replacement. Eearly strength shows that salt curing produced concrete with higher compressive and flexural strength and the best result go for control.

ABSTRAK

Tayar sampah bermotor mempunyai peningkatan yang mantap dalam penjanaannya setiap tahun di Malaysia. Bilangan tayar sisa kenderaan tahunan yang dihasilkan di negara ini dianggarkan berjumlah 8.2 juta atau kira-kira 57,391 tan pada tahun 2006. Tambahan pula, 60% tayar buangan dibuang melalui laluan tidak diketahui. Tayar sisa di Malaysia tidak dikategorikan sebagai sisa pepejal atau sisa berbahaya. Pada masa ini ia hanya menjadi umum sebagai sisa perdagangan. Oleh kerana tidak ada undang-undang atau peraturan yang mentadbir pengurusan tayar sampah, kami telah memutuskan untuk menggunakan bahan ini. Daripada pencahayaan yang dikaji ia menunjukkan bahawa sisa Tirus tidak bersifat mesra alam yang terdiri daripada struktur yang kompleks. Struktur yang tidak dapat dipisahkan oleh tindak balas normal semula jadi dan tidak dapat dikitar semula. Kerja ini menentukan sifat mekanik konkrit selepas penggantian pasir separa dan membandingkan kesan menggunakan dua jenis pengawetan konkrit iaitu pengawetan air dan pengawetan garam dalam kekuatan mampatan dan kekuatan lenturan. Sisa tayar yang digunakan dalam penyelidikan ini digali ke dalam bentuk serbuk dan kemudian digunakan sebahagiannya untuk menggantikan pasir dalam reka bentuk campuran konkrit untuk mencari peratusan yang sesuai untuk digunakan untuk mendapatkan kekuatan optimum. Kukuk konkrit yang diuji dalam kajian ini bersaiz pada (150mm x 150mm x 150mm) masing-masing dan diuji pada peratusan yang berlainan penggantian pasir. K kubus dilemparkan pada 0% (kiub terkawal), 5% dan 10%. Setiap peratusan mempunyai 9 kiub yang sama yang dicoret untuk mendapatkan data purata yang diuji pada hari ke-7 dan ke-28 sejak ia dipecat. Selain itu, untuk ujian lenturan, 18 saiz rasuk 500mm x 100mm x 100mm Kekuatan fleksibel menurun dengan penggantian getah tayar yang semakin meningkat. Kekuatan yang kuat menunjukkan bahawa pengawetan garam dihasilkan konkrit dengan kekuatan mampatan dan lenturan yang lebih tinggi dan hasil yang terbaik dapat dikendalikan..

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LIST OF SYMBOLS

SBPWM	Simple Boost Pulse Width Modulation
˚C	Degree Celsius
%	Percentage
Δ	Tolerance to Accommodate fixing precision
G	Grade

LIST OF ABBREVIATIONS

SBPWM	Simple Boost Pulse Width Modulation
OPC	Ordinary Portland cement
ASTM	American Society for Testing and Materials
FKASA	Fakulti Kejuruteraan Awam dan Sumber Alam
UTM	Universal Testing Machine
UMP	Universiti Malaysia Pahang
US	United State
w/c	Water-Cement ratio
L	Lit
cm2/g	Centimeter square per gram
s/c	Sand-Cement ratio
H	Hour
Mm	Milimeter
Kg/m3	Kilogram per meter cube
CSH	Calcium Silicate Hydrate
CH	Calcium Hydroxide
CO2	Carbon Dioxide
SO3	Sulphur Trioxide
MgO	Magnesium Oxide
kN	kilo Newton
kN/s	kilo Newton per second
kPa	kilo Pascal
^{o}C	Degree Celcius
Mw	Saturated Weight
N	Newton

CHAPTER 1

INTRODUCTION

1.1 Background of Study

The management of waste material is a problem worldwide. In the developing countries, waste management is becoming an acute problem and in Malaysia there are many waste materials being generated daily that demands immediate attention. This has to be taken into serious consideration by the authorities and management because Malaysia is categorized as an emerging industrialized country among countries like China and South Korea (Von Lina Lau, 2004). Tyre dealers face considerable pressure when the waste tyres produced accumulates at their premises, often causing improper place of disposal of the tyre waste. These tyre dealers usually don't have any assistance from their principals or authorities for proper management and disposal of waste tyres Von Lina Lau (2004).

In the past, tires were burned to avoid this accumulation in stockpiles. The tire fires were difficult to extinguish and would release harmful chemicals into the environment resulting in regulations making it illegal to do so in many countries. With approximately 3663 thousand metric tons of tires generated in 2015 in the United States alone, it is critical to continue finding innovative ways to use this waste material (TMA (U.S. Tire Management Association) 2017).

Ultimately, the purpose of this study was to assess the use of recycled tyre particles as a replacement of fine aggregate which is sand with tyre waste powder or crumbs. The effects of replacement on fresh and hardened concrete properties were

determined. In each instance, the fine aggregate, sand, was replaced volumetrically in 5% increments up to the maximum of 10%.

Through this study, we will be working on determining concrete strength on each cube, type of failure on each cube All the cubes at different sand replacement percentage will be tested to compare the concrete strength of the cubes. The type of crack on the cubes will be determined. Therefore, in the end of this study, the feasibility of using rubber tyre waste as partial replacement of fine aggregate in concrete will be verified.

1.2 Problem Statement

Daily, there are tons of tire waste being produced worldwide and even in Malaysia. These tire wastes are stored and doesn't have proper disposal methods. With the rapid usage of automobile in Malaysia the number of cars has increased substantially in the last decade and reached over 120 million in 2016. The weight of waste rubber from tyre wastes is about 15 million tons at present which is very big concern to the authorities. Waste rubber disposal is a major environmental concern in Malaysia, mainly due to this material being a non-decaying material. Stockpiling of these materials is very dangerous because it presents a fire hazard and provides breeding ground for rats, mice and mosquitoes (Liu Rixin, and Lei Zhang, 2015).

The question of suitability of tyre waste material being used as sand replacement is asked because of the properties of tyre waste being an aggregate in concrete. The effects of tyre waste in concrete have been tested in previous studies but not till an extend of knowing its suitability in using tyre waste as sand replacement in concrete for construction purposes.

The vehicle tires which are disposed to landfills constitute one important part of solid waste. Stockpiled tires also present many types of, health, environmental and

economic risks through air, water and soil pollution. The tires store water for a long period because of its particular shape and impermeable nature providing a breeding habitat for mosquitoes and various pests. Tire burning, which was the easiest and cheapest method of disposal, causes serious fire hazards. Once ignited, it is very difficult to extinguish as the 75% free space can store lot of free oxygen. In addition, the residue powder left after burning pollutes the soil. The oil that is generated from the melting of tires can also pollute soil and water. An estimated 1000 million tires reach the end of their useful lives every year. At present enormous quantities of tires are already stockpiled (whole tire) or landfilled (shredded tire), 3000 million inside EU and 1000 million in the US. By the year 2030 the number of tires from motor vehicles is expecting to reach 1200 million representing almost 5000 million tires to be discarded in a regular basis. Tire landfilling is responsible for a serious ecological threat. Mainly waste tires disposal areas contribute to the reduction of biodiversity also the tires hold toxic and soluble components. Secondly although waste tires are difficult to ignite this risk is always present. Once tires start to burn down due to accidental cause's high temperature take place and toxic fumes are generated besides the high temperature causes tires to melt, thus producing oil that will contaminate soil and water.

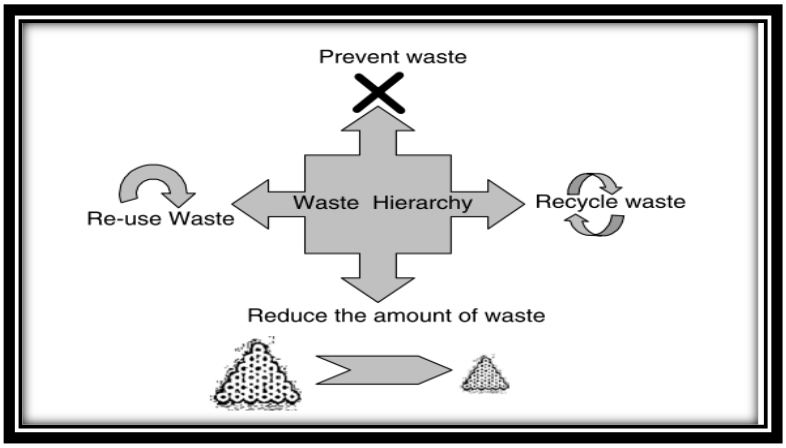

Figure 1. 1: Waste Hierarchy

REFERENCES

Alaejos, P., & Bermúdez, M. A. (2010). Influence of seawater curing in standard and high-strength subl=merged concrete. *Journal of Materials in Civil Engineering*, 23(6), 915-920.

Alam, I., Mahmood, U. A., & Khattak, N. (2015). Use of Rubber as Aggregate in Concrete: A Review. *International Journal of Advanced Structures and Geotechnical Engineering.*

Alengaram, U.J., Muhit, B.A.A. and Jumaat, M.Z. 2013. Utilization of oil palm kernel shell as lightweight aggregate in concrete. Constr. Build. Mater. 38, pp.161-172.

Al-Hadithi, A. I., & Hilal, N. N. (2016). The possibility of enhancing some properties of self-compacting concrete by adding waste plastic fibres. *Journal of Building Engineering*, *8*, 20-28.

Antil, E. Y. (2014). An experimental study on rubberized concrete. International *journal of emerging technology and advanced engineering*, 4(2), 309-316.

Banerjee, S., Mandal, A., & Rooby, J. (2016). Studies on mechanical properties of tyre rubber concrete. SSRG Int. J. Civ. Eng, 3, 18-21.

Bassuoni, M. T., & Rahman, M. M. (2016). Response of concrete to accelerated physical salt attack exposure. *Cement and Concrete Research*, 79, 395-408.

Bompa, D. V., & Elghazouli, A. Y. (2019). Creep properties of recycled tyre rubber concrete. *Construction and Building Materials*, 209, 126-134.

Elchalakani, Mohamed, et al. "Mechanical Properties of Rubberised Concrete for Road Side Barriers." *Australian Journal of Civil*

Gambhir, M.L. 2004. Concrete technology. Tata McGraw-Hill Education, New Delhi.

Fernández-Ruiz, M. A., Gil-Martín, L. M., Carbonell-Márquez, J. F., & Hernández-Montes, E. (2018). Epoxy resin and ground tyre rubber replacement for cement in concrete: Compressive behaviour and durability properties. Construction and Building Materials.

Guo, Q., Chen, L., Zhao, H., Admilson, J., & Zhang, W. (2018). The Effect of Mixing and Curing Sea Water on Concrete Strength at Different Ages. In MATEC Web of Conferences (Vol. 142, p. 02004). EDP Sciences.

Gupta, T., Chaudhary, S., & Sharma, R. K. (2014). Assessment of mechanical and durability properties of concrete containing waste rubber tire as fine aggregate. *Construction and building Materials*, 73, 562-574.

Ho, A. C., Turatsinze, A., Hameed, R., & Vu, D. C. (2012). Effects of rubber aggregates from grinded used tyres on the concrete resistance to cracking. Journal of Cleaner Production, 23(1), 209-215.

Humphrey, D. N., & Manion, W. P. (1992). Properties of tire chips for lightweight fill. *In Grouting, soil improvement and geosynthetics* (pp. 1344-1355). ASCE.

Issa, C. A., & Salem, G. (2013). Utilization of recycled crumb rubber as fine aggregates in concrete mix design. *Construction and Building Materials*, 42, 48-52.

Jusli, E., Nor, H. M., Ramadhansyah, P. J., & Zaiton, H. (2014). Mechanical properties of double layer rubberized concrete paving blocks. In Advanced Materials Research (Vol. 911, pp. 463-467). *Trans Tech Publications*.

Liu Rixin, and Lei Zhang. "Utilization of Waste Tire Rubber Powder in Concrete." Composite Interfaces, vol. 22, no. 9, 2015, pp. 823–835., doi:10.1080/09276440.2015.1065619.

Malladi, K. S. (2004). Studies on rubberized cement concrete. Master Thesis in Structural Engineering, *Civil Engineering Department, IIT Kharagpur*.

Manoharan, P., Ravichandran, P. T., Annadurai, R., & Rajkumar, P. K. (2019). Studies on Properties of Concrete Using Crumb Rubber as Fine Aggregate. In International Conference on Intelligent Computing and Applications (pp. 197-203). Springer, Singapore.

Nuzaimah, M., Sapuan, S. M., Nadlene, R., & Jawaid, M. (2018, June). Recycling of waste rubber as fillers: A review. In IOP Conference Series: *Materials Science and Engineering* (Vol. 368, No. 1, p. 012016). IOP Publishing.

Paine, K.A., Dhir, R.K., Moroney, R., Kopasakis, K. (2002). Use of crumb rubber to achieve freeze thaw resisting concrete. Proceedings of the International Conference on Concrete for Extreme Conditions, University of Dundee, Scotland, UK, pp 486–498.

Rajagopalan, S., Sreehari, P., Mahalingam, B., & Haneefa, K. M. (2019). On Mechanical and Thermal Properties of Concretes with Rubber as Partial Replacement to Well-Graded Conventional Aggregates. *In Advances in Materials and Metallurgy* (pp. 57-65). Springer, Singapore.

Ramadevi, K., & Manju, R. (2012). Experimental investigation on the properties of concrete with plastic PET (bottle) fibres as fine aggregates. *International journal of emerging technology and advanced engineering*, 2(6), 42-46.

Reda Taha, M. M., EI-Dieb, A. S., EI-Wahab, M. A. A., and Abdel-Hameed, M. E. (2008). Mechanical, Fracture, and Microstructural Investigations of Rubber concrete, Journals *of Materials in Civil Engineering, 20(10),* 640-649.

Sgobba, S., Marano, G., C., Borsa, M., Molfetta, M., 2010. Use of rubber particles from recycled tires as concrete aggregate for engineering applications. *Coventry University and The University of Wisconsin Milwaukee Centre for By-products utilization, Second International Conference on Sustainable Construction Materials and Technologies*, June 2010.

Siddique, R., and Naik, T, R. (2004). Properties of concrete containing scrap-tire rubber- an overview. *Waste Management*, 24, 563-569.

Siringi, G., M., Abolmaali, A., Aswath, P., B., 2013. Properties of concrete with crumb rubber replacing fine aggregates (sand). Material Science and Engineering Department, *The University of Texas at Arlington*.

Sofi, A. (2017). Effect of waste tyre rubber on mechanical and durability properties of concrete–a review. *Ain Shams Engineering Journal*

Stallings, Katelyn A., et al. "Effect of Cement Content and Recycled Rubber Particle Size on the Performance of Rubber-Modified Concrete." *International Journal of Sustainable Engineering*, Dec. 2018, pp. 1–12., /oi:10.1080/19397038.2018.1505971.

Su, H., Yang, J., Ling, T. C., Ghataora, G. S., & Dirar, S. (201). Properties of concrete prepared with waste tyre rubber particles of uniform and varying sizes. *Journal of Cleaner Production*, 91, 288-296.

T. Sandra Kumar. "*Waste Tyre Management in Malaysia*". 2006; p.p. 9-2

Von Lina Lau. "Case Study on the Management of Waste Materials in Malaysia". 2004; p.p 51–9.

Taylor, M. A., & Kuwairi, A. (1978). Effects of ocean salts on the compressive strength of concrete. *Cement and Concrete Research*, 8(4), 491-500.

Wegian, F. M. (2010). Effect of seawater for mixing and curing on structural concrete. *The IES Journal Part A: Civil & Structural Engineering*, 3(4), 235-243.

Wakchaure, M. R., Chava P. A., 2014. Waste tyre crumb rubber particle as a partial replacement to fine aggregate in concrete. *International Journal of Engineering Research & Technology*, Vol 3, Issue 4, June 2014.

Youssf, O., Mills, J. E., & Hassanli, R. (2016). Assessment of the mechanical performance of crumb rubber concrete. *Construction and Building Materials*, 125, 175-183.

Zheng, L., Huo, X. S., and Yuan, Y. (2008). Strength, Modulus of Elasticity, and Brittleness Index of Rubberised concrete. Journal of Materials in Civil Engineering, 20(11), 692-699.